CONTRIBUTION TO THE BIOLOGY OF BASS, *DICENTRARCHUS LABRAX* L. IN THE EGYPTIAN MEDITERRANEAN WATERS OFF ALEXANDRIA

by

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ABSTRACT. - Age determination and annual growth of sea bass *Dicentrarchus labrax* L. were conducted from scale-readings. The regression equation representing the relation between fish-length and scale-radius is given. Time of annulus formation on bass scales was determined. Growth rates, in length as well as in weight, were followed up to the 8th year for males and the 15th for females. The curves expressing length/weight relationship were described statisfactorily. Fulton's and Clark's formulae were to express bass condition. Theoretical growth rate was also computed during the first seven years of life, using Bertalanffy's equation. Spawning season extended from January to April with a peak in February. Ova-diameter frequency distribution in the ripe ovaries suggested bass is a fractional spawner. Fish length and age at first maturity identified at 20 cm (2 yr) for males and 29 cm (4 yr) for females. The relationships between absolute and relative fecundity on one hand and either fish length, weight or age on the other hand were studied.

RÉSUMÉ. - La détermination de l'âge et celle de la croissance annuelle du bar *Dicentrarchus labrax* L. ont été effectuées à partir de l'examen des écailles. L'équation de régression représentant la relation entre la longueur du poisson et le diamètre des écailles a été déterminée. Les taux de croissance en taille et en poids ont été calculés jusqu'à la huitième année pour les mâles et jusqu'à la quinzième année pour les femelles. L'époque de formation des anneaux sur les écailles du bar a été déterminée. Les courbes exprimant la relation entre l'âge et le poids ont pu être tracées d'une matière satisfaisante. Les formules de Fulton et de Clark ont été utilisées pour exprimer l'état du bar. Le taux de croissance théorique a été calculé pour les sept premières années de vie en utilisant l'équation de Von Bertalanffy. La saison de ponte s'étend de Janvier à Avril avec un maximum en Février. La fréquence de distribution du diamètre des œufs dans les ovaires "mûrs" permet de classer le bar dans la catégorie des poissons à ponte fractionnée. La longueur et l'âge au début de la maturité ont été observés à 20 cm (2 ans) pour les mâles et à 29 cm (4 ans) pour les femelles. Les corrélations entre fécondité absolue et fécondité relative, d'une part, et la longueur le poids ou l'âge, d'autre part, ont été étudiées.

Key-words : *Dicentrarchus labrax*, MED, Egypt, Condition factor, Scale reading, Age determination, Fecundity.

Although bass *Dicentrarchus labrax* L. (F : bar, local name 'Karous') contributes only 0.2 % of the Egyptian Mediterranean yield, it is considered one of the relatively valuable fishes. Yet, it brings a high market price. Studies on the various biological characteristics of the species in local waters is of prime importance to serve as a basis for its aquaculture development which has been recently initiated in Egypt. Fisheries of bass, food and feeding habits have been dealt with (Wassef *et al.* 1985a, b). This work supplies information on age, growth and reproduction which may be of great benefit to both fishery management and mariculture industry as well. Numerous workers studied bass growth in other areas. Among them may be mentioned : Bou Ain (1977) for Tunisian waters, Gravier (1961) for western coast of Morroco, Andrade (1983) for Portugal coast, Barnabé (1972, 1973, 1976) for the French Mediterranean coast, Boulineau-Coatanea (1969), Lam Hoai Thong (1970) and Stéquert (1972) for the Atlantic coast of France, Kennedy and Fitzmaurice (1972) for Irish waters, Claridge and Potter (1983) and Abrahamian and Barr (1985) for Severn Estuary, U.K. and Kelly (1988) for various parts of U.K. coast. On the other hand, Barnabé (1980) summarized other workers data on bass reproduction in different regions in a valuable review. More reports on this context are those of Roblin and Truslé (1983),

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Dando and Demir (1985) while in Egypt, the work of Rafail (1971) is the only one in record on the subject.

MATERIAL AND METHODS

Bass are mainly caught by bottom-trawls, long lines and beach-seines (Wassef *et al.*, 1985b). Commercial catches of these fishing gears, operating on sea off Alexandria, are landed at two centers. Bass samples were collected fresh, at random, from these centers at almost bimonthly interval from January 1981 to March 1982. 579 specimens, ranging in length from 15.5 to 78 cm were examined fresh in laboratory and the following data were recorded for each individual fish : total length (mm), total and gutted weight (g), scales from the pectoral area for age determination, sex and stage of maturity (visually according to six-stages scale : I, immature ; II, mature ; III, nearly ripe ; IV, ripe ; V, running ; and VI, spent. Partially spent gonads are included in stage V as they are somewhat flaccid, bloodshot but still loaded with eggs or sperm) and gonad weight (mg). 16 ripe ovaries, prior to spawning, were tagged and preserved in 5 % neutral formalin solution for fecundity estimates (Batts, 1972). About 5 % shrinkage of egg-sizes was observed after one month preservation. Only the right lobes were examined since no significant differences in number of ova per gram of lobe were noticed between right and left lobes. Gonad index (G. I) was calculated as percentage of gonad weight to gutted fish weight. Size ranges of ova-diameter, in the subsample, were counted and measured with the aid of eye-piece micrometer (0.01 mm). Scales were cleaned, mounted dry between glass slides and read under a Zoom binocular microscope (Wild M8) with camera lucida at magnification X 25. Age was determined by counting the annuli on the anterior scale radius.

Condition factor'K' was calculated by using total fish weight (Fulton's), or gutted weight (Clark's) as percentage to the cube of length. Total length was used throughout this study and sexes were kept separate.

RESULTS

Age and Growth

Time of annulus formation

Scales of bass showed defined annuli (year mark) indicated by hyaline lines on the anterior region of scale and break in the pattern of circuli on the dorsal and ventral regions (Fig. 1). Only bass specimens of age group 3 + were used to follow the monthly plus-growth, beyond the outer most annulus. Monthly variations of average this distance (Fig. 2) showed minimal value in February, indicating annulus formation in late winter. All bass samples captured after January 27, had a distinct annulus just inside the scale edge whereas bass taken on February 11, showed a plus-growth on their scales as small increment outside the newly formed annulus. Accordingly, annulus is formed within a period between 27th January and 11th February.

Fish length/scale radius relationship

Scatter diagram between fish length (L) and average scale radii (S) showed approximately straight line. Test of linearity (Snedecor and Cochran, 1980) confirmed the relation : $L = a + b\,S$, where a and b are constants determined by the least squares method. The following regression equation was arrived at (Fig. 3) for bass : $L = 2.3845 + 8.0173\,S$ .. (1). The value'2.38' suggests a hypothetical length at first scale formation. L/S ratio showed a slightly decreasing trend with the increase in fish length.

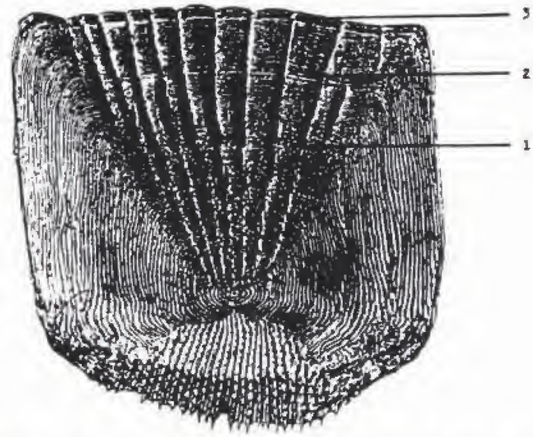

Fig. 1 : Scale of bass *Dicentrarchus labrax*, aged 3+, caught on March 15, 1982. Total fish length : 25.2 cm.

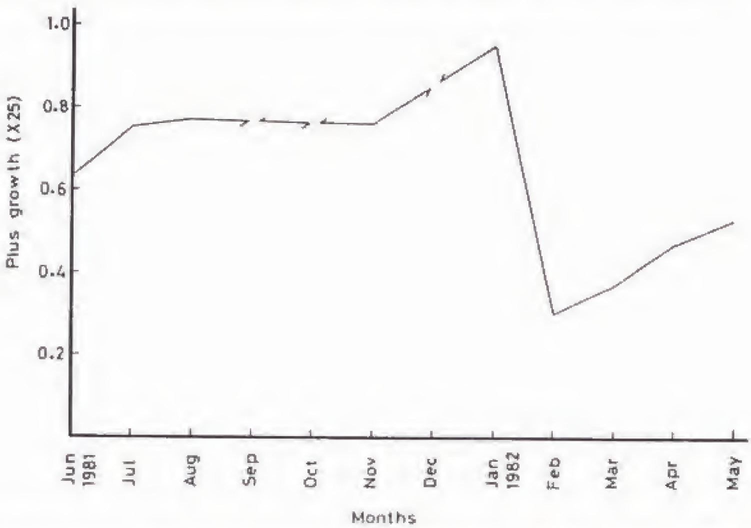

Fig. 2 : Monthly average growth increments (plus-growth) of age group III of bass *D. labrax* in the Egyptian Mediterranean waters off Alexandria.

Growth in length

Back-calculated lengths at previous ages were computed using the formula :

$$Ln = \frac{Sn}{S} (L-a) + a$$ (Lee, 1921).

Where L = fish length at capture, S = total scale radius, Ln = length of fish when annulus'n' is formed, Sn = scale radius to annulus'n', and 'a' = constant from regression line (a = 2.38). This equation was applied for each individual fish and results are summarized in Tables I and II. Grand average calculated lengths and sum of average annual increments are almost identical and can represent calculated length of bass at previous ages. However, growth studies based on sum of average increments were held to be more descriptive of biological growth potential and therefore was chosen in the present work. Since maximum age obtained was 8 yr for males and 15 yr for females, Table II was established to make data comparable. Agreement between the observed and calculated lengths, for each age-group is evident (Tables

Table I : Average calculated lengths for female bass *D. labrax* at the end of different years of life (increment in parentheses).

Age groups	No. of fish	Av. length at capture	Average calculated lengths (cm) L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}	L_{15}
I	39	18.3 ±1.1	15.1 (15.1)														
II	57	20.8 ±1.2	14.1 (14.1)	18.7 (4.6)													
III	39	24.1 ±1.0	13.9 (13.9)	18.7 (4.8)	22.1 (3.4)												
IV	31	27.6 ±1.0	13.8 (13.8)	18.8 (5.0)	22.1 (3.4)	25.5 (3.4)											
V	31	30.9 ±1.3	13.6 (13.6)	18.4 (4.7)	21.8 (3.4)	25.2 (3.5)	29.0 (3.8)										
VI	9	34.9 ±1.1	13.4 (13.4)	18.2 (4.7)	21.5 (3.3)	25.2 (3.7)	29.5 (4.3)	33.1 (3.6)									
VII	13	38.9 ±1.1	13.5 (13.5)	18.7 (5.2)	22.1 (3.4)	25.8 (3.7)	29.9 (4.1)	33.6 (3.7)	36.6 (3.0)								
VIII	16	42.4 ±1.6	12.8 (12.8)	17.9 (5.1)	21.9 (4.0)	25.7 (3.8)	29.8 (4.1)	33.4 (3.6)	36.7 (3.3)	40.2 (3.5)							
IX	10	47.1 ±1.4	13.1 (13.1)	18.2 (5.1)	22.0 (3.8)	25.6 (3.7)	29.5 (3.9)	33.1 (3.6)	36.6 (3.4)	40.4 (3.9)	44.4 (4.0)						
X	3	49.6 ±1.4	12.9 (12.9)	17.9 (5.0)	21.9 (4.1)	25.7 (3.7)	29.2 (3.6)	32.9 (3.7)	36.4 (3.5)	40.3 (3.9)	43.9 (3.6)	47.5 (3.7)					
XI	4	53.0 ±1.2	13.0 (13.0)	18.1 (5.1)	21.8 (3.7)	25.6 (3.8)	29.8 (4.1)	33.3 (3.6)	36.6 (3.4)	40.5 (3.8)	44.5 (4.0)	48.5 (4.1)	52.2 (3.7)				
XII	7	58.4 ±1.5	12.5 (12.5)	17.6 (5.1)	21.7 (4.1)	25.7 (3.9)	29.7 (4.0)	33.1 (3.4)	36.4 (3.4)	40.4 (3.9)	44.4 (4.1)	48.4 (4.0)	52.5 (4.1)	56.5 (4.1)			
XIII	1	60.0 ±0.0	12.5 (12.5)	17.7 (5.3)	21.7 (3.9)	24.9 (3.3)	29.2 (4.3)	33.0 (3.8)	36.2 (3.3)	40.3 (4.1)	44.4 (4.1)	48.5 (4.1)	52.5 (3.9)	55.9 (3.4)	59.2 (3.3)		
XIV	1	64.0 ±0.0	12.5 (12.5)	17.6 (5.1)	22.0 (4.4)	25.6 (3.6)	29.2 (3.6)	32.9 (3.6)	36.1 (3.3)	40.1 (4.0)	44.2 (4.0)	48.2 (4.0)	52.2 (4.0)	56.2 (4.0)	59.8 (3.6)	62.9 (3.1)	
XV	1	67.0 ±0.0	12.6 (12.6)	17.3 (4.7)	21.3 (4.0)	25.3 (4.0)	29.3 (4.0)	33.3 (4.0)	36.6 (3.3)	39.9 (3.3)	44.2 (4.3)	48.5 (4.3)	52.9 (4.3)	56.5 (3.7)	60.5 (4.0)	63.8 (3.3)	66.3 (2.5)
Grand average calculated lengths			13.3 ±0.7	18.1 ±0.5	21.8 ±0.2	25.5 ±0.2	29.5 ±0.2	33.2 ±0.2	36.3 ±0.2	40.3 ±0.2	44.3 ±0.2	48.3 ±0.4	52.4 ±0.3	56.3 ±0.3	59.8 ±0.6	63.4 ±0.5	66.3 ±0.0
Increment of grand average lengths			13.3	4.8	3.7	3.7	4.0	3.7	3.3	3.8	4.0	4.0	4.2	3.8	3.6	3.5	3.0
Average annual increment of lengths			13.3 ±0.7	5.0 ±0.2	3.8 ±0.3	3.7 ±0.2	4.0 ±0.2	3.7 ±0.1	3.3 ±0.1	3.8 ±0.2	4.0 ±0.2	4.0 ±0.2	4.0 ±0.2	3.8 ±0.3	3.6 ±0.3	3.2 ±0.1	2.5 ±0.0
Sum of average increments (calculated lengths			13.3	18.3	22.0	25.7	29.6	33.3	36.6	40.4	44.4	48.5	52.5	56.3	59.9	63.1	65.6

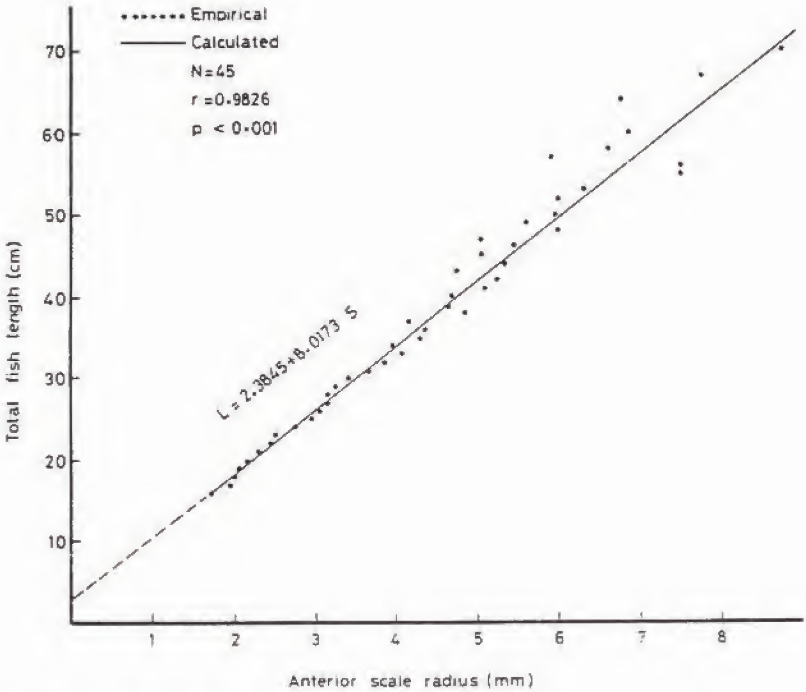

Fig. 3 : Fish length/scale radius relationship for bass *D. labrax*.

I and II). Highest growth in length took place during first year of life after which length-increment and percentage increase gradually and progressively decreased with further increase in age (Fig. 4). The same figure clarifies that growth rate of females is slightly higher than that of males.

Length/weight relationship

Data on a scatter diagram suggested curvilinear trend between fish lentgh (L) and weight (W). The straight line "log W = log a + b log L" was fitted by the least squares method. The following equations were derived for separate groupings of bass :

For male, Log W = -2.1002+3.0803Log L...(2), (n:264,r=0,997)
For female untill 8 yr, Log W=-2.0149+3.0227Log L...(3), (n=261,r=0.998)
For all female, Log W=-2.0276+3.0319Log L...(4), (n=302,r=0.999)
For sexes combined, Log W=-2.0579+3..0503Log L...(5), (n=528,r=0.999)

These formulae can be used to estimate weight of bass when only length is known. The value of exponent 'b' in the equation $W=aL^b$ is nearly equal in males and females, i.e both sexes increase in weight in a manner almost equal to the cube of their length. However, empirical weights of females less than 29 cm were higher than those of males, whereas the reverse is true for bigger sizes.

Condition factor 'K'

Coefficient of condition 'K' is an expression of the relative conditon of "robustness" of fish. These values are used to indicate the suitability of an environment or to compare fish from different locations. Variations of mean condition factor 'K', of Fulton's and Clark's formulae, with bass length are shown in Figure 5. For males 'K' were gradually increased with length and peaked at length range 35.5-40.4 cm, then decreased thereafter. Similarly for females, a peak 'K'

Table II : Average calculated lengths for bass *D. labrax*. (males and females), at the end of different years of life (increment in parentheses).

Age	No of fish		Av. length at capture(cm)		Average calculated lengths (cm)															
					L_1		L_2		L_3		L_4		L_5		L_6		L_7		L_8	
group	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀
I	46	85	18.1 ±0.9	18.2 ±1.0	15.3 (15.3)	15.2 (15.2)														
II	50	107	20.3 ±1.2	20.6 ±1.2	13.7 (13.7)	13.9 (13.9)	18.3 (4.6)	18.5 (4.6)												
III	39	78	23.9 ±1.2	33.0 ±1.1	13.6 (13.6)	13.8 (13.8)	18.4 (4.8)	18.6 (4.8)	21.9 (3.5)	22.0 (3.4)										
IV	37	68	27.2 ±1.5	27.4 ±1.3	13.5 (13.5)	13.6 (13.6)	18.3 (4.9)	18.5 (4.9)	21.7 (3.4)	21.9 (3.4)	25.1 (3.4)	25.3 (3.4)								
V	25	56	31.2 ±1.4	31.1 ±1.4	13.5 (13.5)	13.6 (13.6)	18.1 (4.5)	18.2 (4.6)	21.5 (3.5)	21.7 (3.4)	25.3 (3.8)	25.3 (3.6)	29.0 (3.7)	29.0 (3.7)						
VI	25	34	34.7 ±1.0	34.7 ±1.0	13.4 (13.4)	13.4 (13.4)	18.2 (4.8)	18.2 (4.8)	21.6 (3.4)	21.6 (3.4)	25.4 (3.8)	25.4 (3.8)	29.4 (4.1)	29.4 (4.1)	32.7 (3.3)	32.8 (3.3)				
VII	8	21	37.6 ±0.8	38.4 ±1.2	12.7 (12.7)	13.2 (13.2)	17.9 (5.2)	18.4 (5.2)	21.7 (3.8)	21.9 (3.6)	25.6 (3.9)	25.7 (3.8)	29.5 (4.0)	29.7 (4.0)	33.2 (3.7)	33.5 (3.7)	36.0 (2.8)	36.4 (2.9)		
VIII	2	18	44.1 ±0.3	42.6 ±1.6	12.9 (12.9)	12.8 (12.8)	17.9 (5.0)	17.9 (5.1)	22.0 (4.1)	21.9 (4.0)	25.8 (3.7)	25.7 (3.8)	29.8 (4.1)	29.8 (4.1)	33.2 (3.5)	33.4 (3.6)	36.5 (3.3)	36.7 (3.3)	40.3 (3.7)	40.2 (3.5)
Grand average calculated lengths					13.6 ±0.7	13.7 ±0.7	18.2 ±6.2	18.3 ±0.2	21.7 ±0.2	21.8 ±0.2	25.4 ±0.2	25.5 ±0.2	29.4 ±0.3	29.5 ±0.3	33.0 ±0.3	33.2 ±0.3	36.2 ±0.3	36.5 ±0.2	40.3 ±0.0	40.2 ±0.0
Increment of grand average lengths					13.6	13.7	4.6	4.6	3.6	3.5	3.7	3.6	4.0	4.0	3.6	3.7	3.2	3.3	4.0	3.7
Average annual increment of lengths					13.6 ±0.7	13.7 ±0.7	4.8 ±0.2	4.9 ±0.2	3.6 ±0.3	3.5 ±0.2	3.7 ±0.2	3.7 ±0.2	3.9 ±0.1	4.0 ±0.2	3.5 ±0.2	3.6 ±0.2	3.0 ±0.3	3.1 ±0.2	3.7 ±0.0	3.5 ±0.0
Sum of average increments (calculated lengths)					13.6	13.7	18.4	18.5	22.0	22.1	25.7	25.7	29.6	29.7	33.1	33.3	36.1	36.4	39.9	39.9

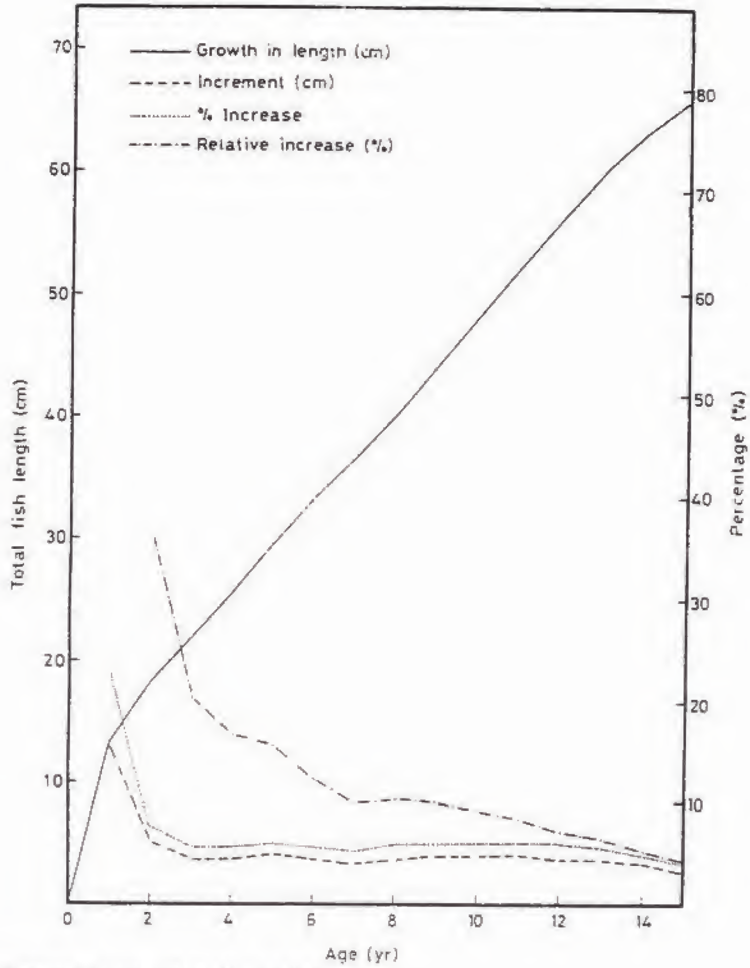

Fig. 4 : Growth in length with age for bass *D. labrax*.

was attained at larger length range 65.5-70.4 cm, followed by a drop towards larger sizes. Generally, an increasing trend of 'K' with the increase of length, for both sexes, is noticeable (Fig. 5). Average 'K' for females (1.06±0.04) is always slightly higher than that of males (1.04±0.03) even when computed using gutted weights. These values can be considered as being representative for Egyptian bass. Monthly variations of average 'K' (Fig. 6) demonstrates three peaks, in August, December and April-May for females or May-June for males. A smaller peak is noticed, for females only (Fulton's curve), in February (peak spawning).

Growth in weight

Likewise, calculated weights at the end of each year of bass life were computed (Tables III and IV) by applying the corresponding length/weight equations 2,3,4 and 5, in turn, to calculated lengths given in Tables I and II. Figure 7 shows the variation of annual growth in weight (A), annual increment (B) and percentage annual gain (C) with age. Growth rate is much slower at earlier ages and increment gradually increased reaching maximum values at the 8th year for males and the 13th and 14th year for females, then decreased thereafter.

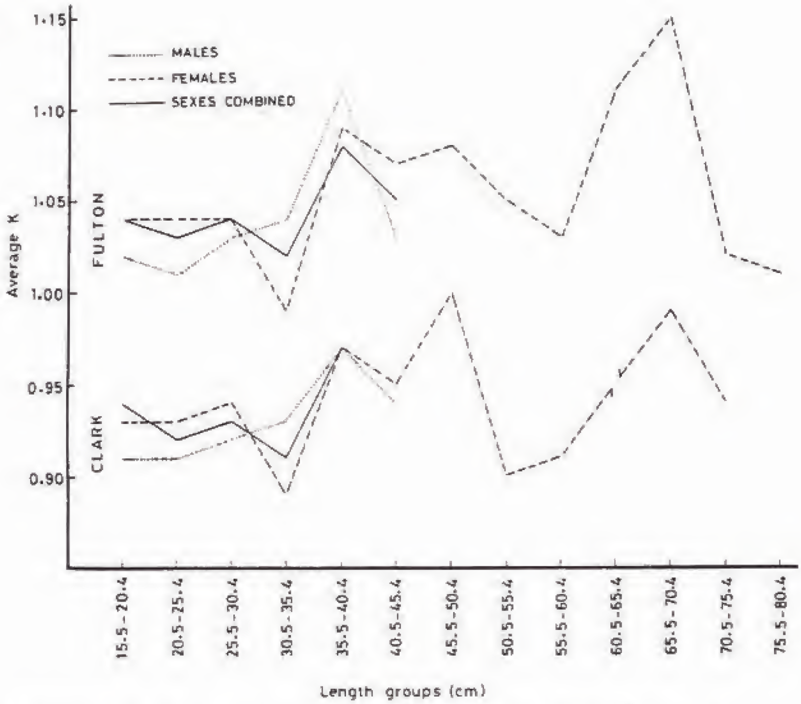

Fig. 5 : Mean condition factor of Fulton's and Clark's for different length groups of bass *D. labrax*.

Theoretical Growth Rate

Growth models are the most convenient tools which can give an idea on the growth pattern of a certain fish species. Parameters of Bertalanffy's growth equation have the next values for Egyptian bass (aged 7 +):

$Lt = 78.1\,(1 - e^{-0.0751\,(t + 1.765)})$... for males
$Lt = 87.8\,(1 - e^{-0.0611\,(t + 1.797)})$... for females
$Lt = 83.2\,(1 - e^{-0.656\,(t + 1.745)})$... for sexes combined

Maximum expected weights are obtained using $L\infty$ and length/weight equations 2,3 and 5 as follows : $W\infty = 5367.02$ for males ; 7239.37 for females and 6295.82 for sexes combined.

Reproduction

Monthly distribution of maturity stages

Table V shows the monthly variations of maturity stages II to VI (juveniles were excluded since they have not yet engaged in reproduction). Spawning season probably extended for about four months from January to April with a peak in February, when about 46 % of males and 43 % of females investigated were running. The appearance of completely spent females in January suggests a rather short spawning season (one month) for some fishes. Ripe males identified one month earlier (late December) than ripe females (January). The presence of partially spent individuals drive the assumption that bass is a fractional spawner.

Gonad index (G.I)

Maximum G. I values were about 7 % for males and 20 % for females, i.e ovary weight reaches about one fifth of gutted weight of bass (about 15 % of total weight). Gonad indices of females were always higher than those of males, except in January when the reverse is true (Fig.

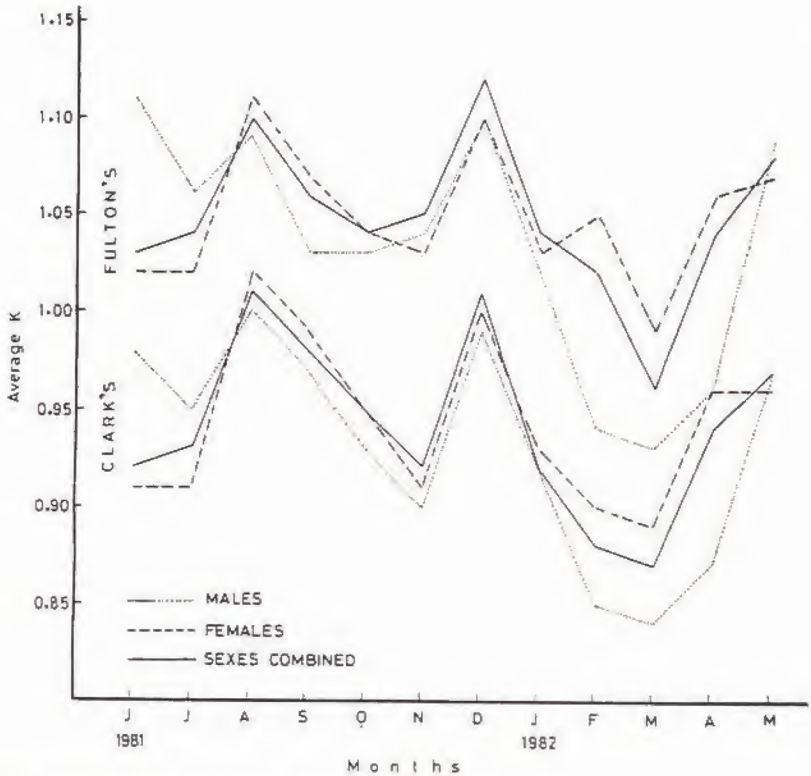

Fig. 6 : Monthly variations of mean condition factor for bass *D. labrax*.

8). Gonads were in rest condition from May to November (G I is less than 1). They began to develop in December, reach a maximum value in January for males in February for females, indicating the peak of breeding season.

Both results of maturity stages (Table V) and gonad indices (Fig 8) verify each other.

Size and age at first sexual maturity

Knowledge on size at first maturity has its practical application in the determination of minimum legal size to catch. Bass samples collected during the prespawning and spawning periods were identified to either immature or mature ones (that are going to participate in next spawning). Percentage frequency distribution for both categories with fish length is given in Table VI. Males attain first maturity at length range 17-22 cm, while that for females is 23-32 cm. Fish bigger than 22 cm for males and 32 cm for females were all sexually mature. It is accepted that length at which 50 % of examined animals acquire a certain character is the length representing the onset of that character (Snedecor and Cochran, 1980). Therefore, length at first maturity is 20 cm for males and 29 cm for females bass. Referring these lengths to respective age group it is evident that bass attain its maturity at age 2^+ and 4^+yr for males and females respectively.

Ova-diameter frequency distribution in the maturing ovaries

Thorough examination of ripe ovaries revealed the presence of more than one size-group of yolky and translucent eggs, which will probably be spawned during the current season. Besides, those minute, undeveloped, pale ova or ovocytes (diameter < 0.2 mm). They form the stock from which a quota matures during breeding. As those ova mature the deposition of yolk enlarges them and makes them opaque. Consequently, after they reach a certain size, oil globules

Table III : Average calculated weights for female bass *D. labrax*. at the end of different years of life (increment in parentheses).

Age group	No. of fish	Calculated weights w (g)														
		W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	W_{14}	W_{15}
I	39	34.5 (34.5)														
II	57	28.4 (28.4)	67.5 (39.1)													
III	39	27.7 (27.7)	67.5 (39.8)	111.5 (44.0)												
IV	31	26.7 (26.7)	68.1 (41.4)	112.1 (44.0)	173.4 (61.3)											
V	31	25.9 (25.9)	63.8 (37.9)	106.7 (42.9)	167.3 (60.6)	255.1 (87.8)										
VI	9	24.7 (24.7)	61.8 (37.1)	102.6 (40.8)	166.5 (63.9)	268.4 (101.9)	379.1 (128.7)									
VII	13	25.0 (25.0)	66.8 (41.8)	111.5 (44.7)	177.9 (66.4)	279.6 (101.7)	399.3 (115.2)	516.5 (117.2)								
VIII	16	21.3 (21.3)	58.7 (37.4)	108.5 (49.8)	175.6 (67.1)	275.9 (100.3)	391.1 (115.2)	519.5 (128.4)	686.4 (166.9)							
IX	10	22.9 (22.9)	62.2 (39.3)	109.8 (47.6)	175.4 (65.6)	268.4 (93.0)	381.9 (113.5)	514.8 (132.9)	697.9 (183.1)	927.7 (229.8)						
X	3	21.6 (21.6)	58.5 (36.9)	109.4 (50.9)	175.6 (66.2)	260.5 (84.9)	372.6 (112.1)	508.0 (135.4)	689.5 (181.5)	894.5 (205.0)	1140 (245.5)					
XI	4	22.4 (22.4)	61.4 (39.0)	107.6 (46.2)	174.6 (67.0)	273.1 (98.5)	386.1 (113.0)	517.4 (131.3)	699.4 (182.0)	930.2 (230.8)	1212 (281.8)	1517 (305)				
XII	7	20.4 (20.4)	56.5 (36.5)	106.2 (49.7)	176.1 (69.9)	272.8 (96.7)	379.1 (124.3)	508.9 (129.8)	693.7 (184.8)	929.0 (235.3)	1205 (276.0)	1540 (335)	1929 (389)			
XIII	1	19.8 (19.8)	57.3 (37.5)	105.2 (47.9)	161.3 (56.1)	260.2 (98.9)	375.7 (115.5)	500.9 (125.2)	693.2 (192.3)	929.0 (235.8)	1214 (285.0)	1537 (323)	1864 (327)	2216 (352)		
XIV	1	19.8 (19.8)	55.9 (36.1)	109.5 (53.6)	174.4 (64.9)	261.0 (86.6)	372.6 (111.6)	497.1 (124.5)	683.3 (186.2)	912.0 (228.7)	1186 (274.0)	1512 (326)	1891 (379)	2288 (397)	2667 (379)	
XV	1	20.5 (20.5)	53.0 (32.5)	99.6 (46.6)	167.7 (68.1)	261.8 (94.1)	385.8 (124.0)	514.3 (129.0)	670.5 (155.7)	915.7 (245.2)	1215 (299.3)	1574 (359)	1927 (353)	2371 (444)	2788 (417)	3132 (344)
Average calculated weights		24.1 ±4.1	61.4 ±4.7	107.7 ±3.5	172.2 ±4.9	267.0 ±7.4	382.3 ±8.0	510.9 ±7.3	689.2 ±8.7	919.7 ±12.3	1195 ±26.6	1536 ±21.9	1903 ±27.0	2292 ±63.3	2728 ±60.5	3132 ±0.0
Increment of average		24.1	37.3	46.3	64.5	94.8	115.3	128.6	178.3	230.5	275.3	341	367	389	436	404
Average annual increment of weights		24.1 ±4.1	38.0 ±2.3	46.8 ±3.4	64.8 ±3.6	95.0 ±5.9	117.8 ± 5.7	128.2 ± 5.1	179.1 ±11.1	230.1 ±11.5	276.5 ±16.3	329.6 ±17.6	362.0 ±24.1	397.7 ±37.6	398.0 ±19.0	344.0 ± 0.0
Sum of average increments		24.1	62.1	108.9	173.7	268.7	386.5	514.7	693.8	923.9	1201	1530	1892	2290	2688	3032

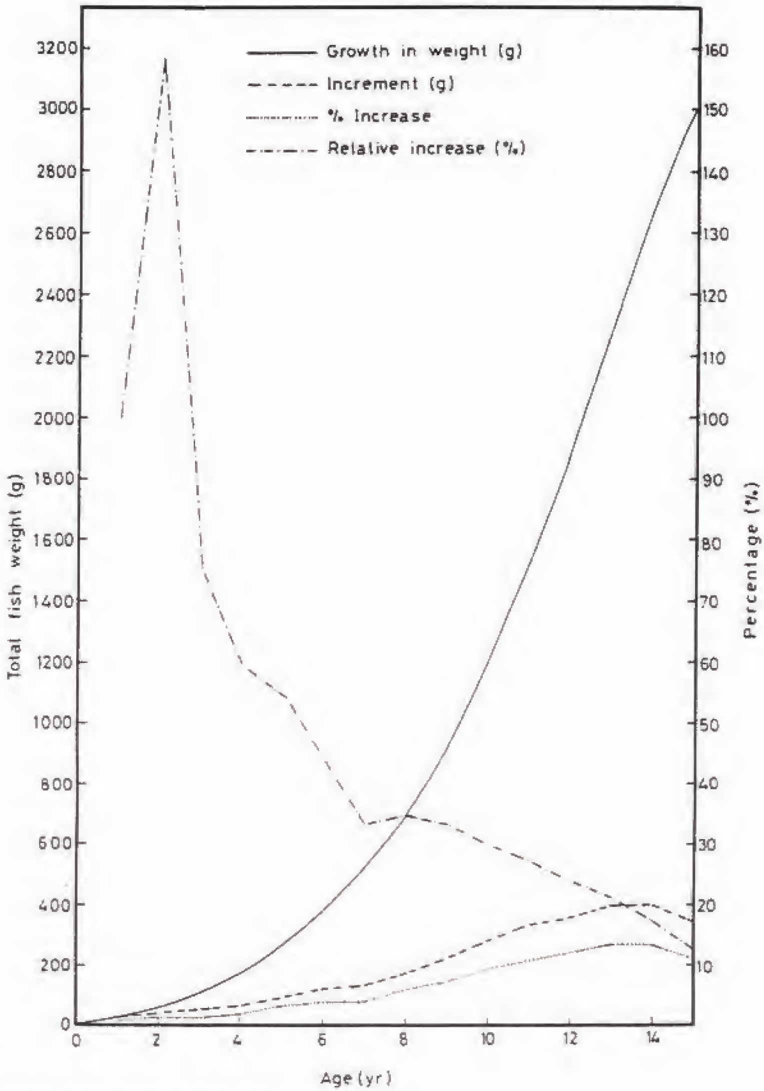

Fig. 7: Growth in weigth with age of bass *D. labrax*.

began to appear and larger ova began to be translucent which means they would be shed soon. Average range of ova-diameter containing oil globules was 1.125-1.230 mm. Figure 9 shows size frequency distribution of ova in four fishes with different maturity stages, chosen to illustrate bass mode of reproduction. Only mature ova (>0.2 mm), which are likely to be shed in the current season, were represented in Figure 9 as follows :

A-A nearly ripe stage : ova exhibit multimodes size distribution, suggesting a continous maturation process. Three or more ova size-groups could be detected. An increase in the number of ova as their size enlarged is also noticeable. All ova were yellow in colour. Largest size-group (0.58-0.83 mm) constituted 49 % af all.

B-A fully ripe stage : in this more developed stage, a characteristic group of orange ova (0.85-1.15 mm), made up about 75 % of all is distinguished. Oil globules began to appear within 1 % of the largest ova (> 1.13 mm). This advanced stage may be considered as the first patch which will be shed soon.

Table IV : Average calculated weights of bass (males and females), at the end of different years of life (increment in parentheses).

Age group	No of fish		Calculated weights W (g)															
			W_1		W_2		W_3		W_4		W_5		W_6		W_7		W_8	
	♂	♂&♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀	♂	♂ & ♀
I	46	83	35.1 (35.1)	35.2 (35.2)														
II	50	107	25.3 (25.3)	26.8 (26.8)	61.6 (36.3)	64.4 (37.6)												
III	39	78	24.8 (24.8)	26.1 (26.1)	62.6 (37.8)	64.8 (38.7)	107.3 (44.7)	108.9 (44.1)										
IV	37	68	23.8 (23.8)	25.1 (25.1)	61.6 (37.8)	64.4 (39.3)	103.3 (41.7)	106.9 (42.5)	161.7 (58.4)	166.3 (59.4)								
V	25	56	24.2 (24.2)	25.1 (25.1)	59.0 (34.8)	61.4 (36.3)	101.3 (42.3)	103.7 (42.3)	166.7 (65.4)	166.1 (62.4)	253.3 (86.6)	252.8 (86.7)						
VI	25	34	23.7 (23.7)	24.2 (24.1)	60.6 (36.9)	61.2 (37.0)	102.6 (42.0)	102.5 (41.3)	169.4 (66.8)	168.1 (65.6)	264.5 (95.1)	264.2 (96.1)	365.7 (101.2)	366.7 (102.5)				
VII	8	21	19.9 (19.9)	22.8 (22.8)	57.3 (37.4)	62.7 (39.9)	103.2 (45.9)	107.7 (45.0)	172.4 (69.2)	174.7 (67.0)	266.4 (94.0)	272.7 (98.9)	385.0 (118.6)	391.1 (118.4)	492.0 (107.0)	504.0 (112.9)		
VIII	2	18	21.1 (21.1)	20.9 (20.9)	57.7 (36.6)	57.7 (36.8)	108.7 (51.0)	107.2 (49.5)	176.0 (67.3)	174.1 (66.9)	274.6 (98.6)	273.9 (99.8)	385.4 (110.8)	388.3 (114.4)	516.4 (131.0)	517.7 (128.9)	696.7 (180.3)	685.1 (167.9)
Average calculated weights			24.7 ±4.3	25.8 ±4.0	60.1 ±1.9	62.4 ±2.3	104.4 ±2.7	106.2 ±2.3	169.2 ± 4.9	169.9 ± 3.8	264.7 ± 7.6	265.9 ± 8.4	378.7 ± 9.2	382.0 ± 10.9	504.2 ± 12.2	510.6 ± 6.6	696.7 ± 0.0	685.1 ±0.0
Increment of average			24.7	25.8	35.4	36.6	44.3	43.8	64.8	63.7	95.5	96.0	114.0	116.1	125.5	128.6	192.5	174.5
Average annual increment of weights			24.7 ±4.3	25.8 ±4.0	36.8 ±1.0	37.9 ±1.3	44.6 ±3.2	44.1 ±2.7	65.4 ±3.7	64.3 ±3.0	93.6 ± 4.4	95.2 ±5.1	110.2 ±7.1	111.8 ±6.8	119.0 ±12.0	120.9 ±8.0	180.3 ±0.0	167.9 ±0.0
Sum of average increment			24.7	25.8	61.5	63.7	106.1	107.8	171.5	172.1	265.1	267.3	375.3	379.1	494.3	500.0	674.6	66.79

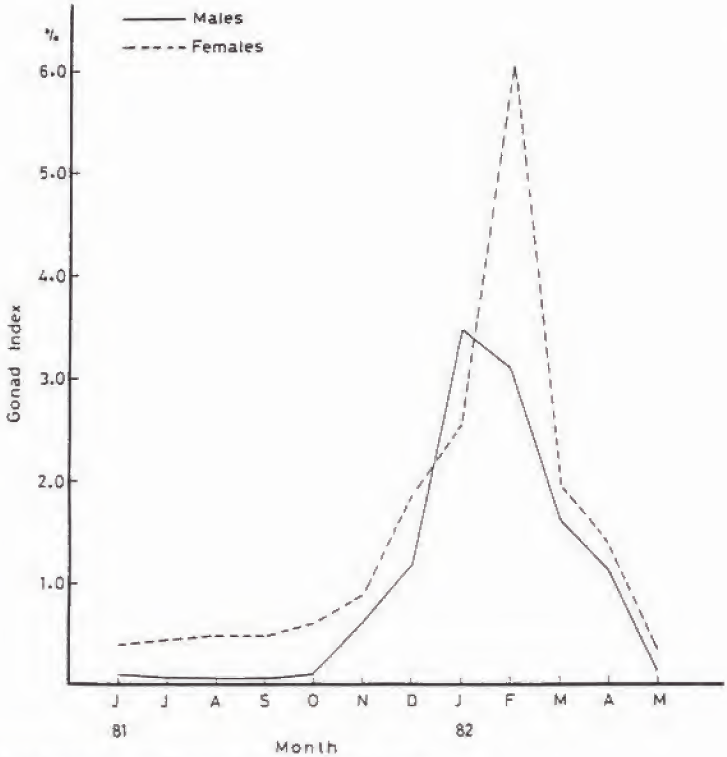

Fig. 8 : Monthly variations of gonad index of bass *D. labrax*.

C-A partially spent stage : absence of ovocytes (>0.46 mm) may suggest the stop of ova development from the stock, as soon as breeding start. However, it is not known whether this process occurs directly after shedding the first patch of after several ones. Ova forming the present multimodes are the remainders which will be spawned later on the season, when they reach their maximum stage of development. More than one patch may still to be considered to be shed as signified from the high value of G I (15 %).

D-Almost completely spent stage : only one size-group of ova (0.67-0.98 mm) could be shown. They may represent the last patch, due to their very advanced stage of development. The low value of G I (5.6 %) and time of capture (April) are likely to confirm this assumption.

Therefore, bass is probly a fractional spawner, their ripe ova, with oil globules, have diameters between 1.125-1.23 mm.

Fecundity

Absolute fecundity is defined, for the purpose of this study as the number or ripe ova which will be released by a female in a spawning season. Relative fecundity is another term also applied to denote the number of ova per unit length or weight of fish. For bass, fecundity ranged between 231,875 (fish length 33 cm) and 808,581 eggs (length 57 cm).

Relation between fecundity and fish length

Both absolute and relative fecundities of bass were shown to increase with the increase of fish length (Fig. 10). The following regression equations were derived to represent these relations :

$F = -461096.16 + 24029.42\ L$ and $F' = -1311.1 + 275.36\ L$ where F and F' are absolute and relative fecundity respectively, and L is fish length (cm).

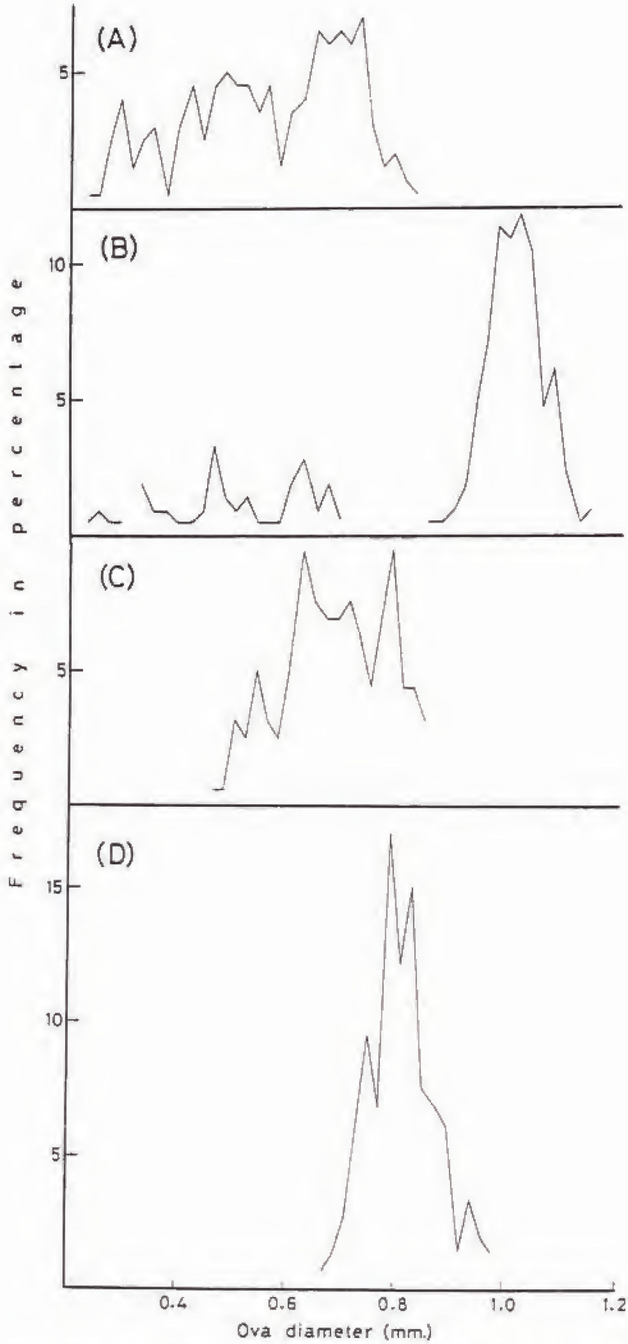

Fig. 9 : Size frequency ditribution of ova diameter in 4 different maturity stages of bass *D. labrax* (1981-1982). (A) - A nearly ripe bass of 45.0 cm total length (TL), caught on 16th January, gonad index (GI) = 9.97 % ; (B) - a fully ripe bass of 48.2 cm TL caught on 27th January, GI = 18.59 % ; (C) - a partially spent bass, 36.0 cm TL caught on 11th February, G I = 15,05 % ; (D) - a partially spent bass, 57.8 cm TL, caught on 4 th April, G I = 5.62 %.

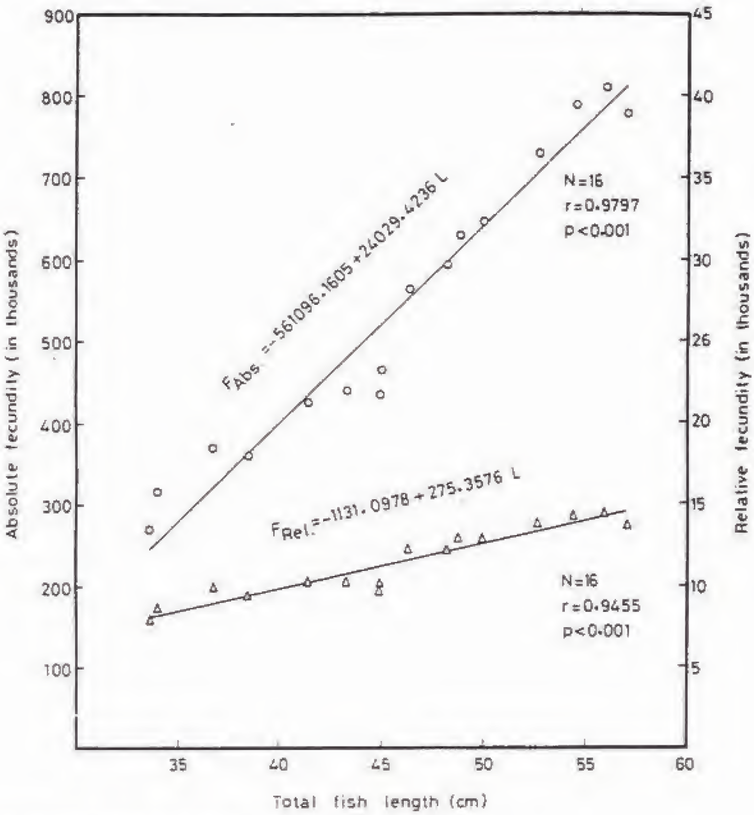

Fig. 10 : Fecundity/total length relationship for bass *D. labrax*.

Relation between fecundity and fish weight

Likewise, absolute fecundity and fish gutted weight are directly proportional. Whereas the relation between relative fecundity and weight is an inversely one, i.e relative fecundity decreases with the increase in bass weight (Fig. 11). The following formulae were calculated to express such reations :

F = 156834.98 + 401.00 W and F' = 807.04 - 0.2111 W where W is gutted fish weight (g).

Relation between absolute fecundity and fish age

Absolute fecundity showed gradual increase with fish age up to age group XI, thereafter it becomes more or less constant (Fig. 12).

DISCUSSION

The validity of scales for ageing bass has been assessed by many authors (Rabail, 1971 ; Kennedy and Fitzmaurice, 1972 ; Barnabé, 1973 ; Bou Ain, 1977 ; Ottaway and Simkiss, 1979 ; Kelly, 1988). Although other structures such as otolith (Boulineau-Coatanea, 1969) and operculum (Kennedy and Fitzmaurice, 1972) have been used satisfactorily for such purpose, the traditional scale method gives good results (Ottaway and Simkiss, 1979). However, there are indications, from the present work, that bass grew faster in some years than in others, which is quite often remarked on individual scales. It seems that best growth occurred during warmer summers. Moreover, growth does not cease in winter, but rather slows down (Fig. 2) and then resumes in spring and summer feature known to occur with various fish species in temperate zones.

Table V : Monthly variations in the percentage of fish in each maturity stage for both sexes of bass *D. labrax*., in the Egyptian Metiterranean waters off Alexandria (number of fish in parentheses).

Month	% males in each maturity state						% female in each maturity stage.					
	II	III	IV	V	VI	Total No of Fish	II	III	IV	V	VI	Total No of fish
June 1981	--	--	--	--	100.0 (11)	11	--	--	--	--	100.0 (14)	14
July	--	--	--	--	100.0 (11)	13	--	--	--	--	100.0 (10)	10
August	53.9 (7)	--	--	--	46.2 (6)	13	--	--	--	--	100.0 (2)	2
Septmeber	85.7 (6)	--	--	--	14.3 (1)	7	61.5 (8)	--	--	--	38.5 (5)	13
October	87.5 (7)	12.5 (1)	--	--	--	8	80.0 (4)	--	--	--	20.0 (1)	5
November	84.2 (16)	15.8 (3)	--	--	--	19	100.0 (10)	--	--	--	--	10
December	57.5 (23)	25.0 (10)	17.5 (7)	--	--	40	75.0 (6)	25.0 (2)	--	--	--	8
January 1982	13.3 (4)	20.0 (6)	36.7 (11)	30.0 (9)	--	30	14.8 (4)	29.6 (8)	33.3 (9)	14.8 (4)	7.4 (2)	27
February	--	9.1 (3)	27.3 (9)	45.5 (15)	18.2 (6)	33	--	7.10 (1)	35.70 (5)	42.9 (6)	14.3 (2)	14
March	--	--	12.9 (4)	38.7 (12)	48.4 (15)	31	--	5.3 (1)	10.5 (2)	31.6 (6)	52.6 (10)	19
April	--	--	--	16.7 (2)	83.3 (10)	12	--	--	--	9.10 (2)	90.9 (20)	22
May	--	--	--	--	100.0 (11)	11	--	--	--	--	100.0 (20)	20

Time of annulus formation recorded in the present work is somewhat earlier than that determined for European bass in Irish (Kennedy and Fitzmaurice, 1972), French Mediterranean (Barnabe, 1973) and U. K. waters (Kelly, 1988), but in accordance with that of Rafail, (1971). This appears logic since annulus formation is a temperature-dependent criterion. The present study's length at first scale-formation (2.4 cm, $P < 0.01$) is similar to that given by Kennedy and Fitzmaurice (1972) (2.5 cm fork-length = about 2.6 cm total length) and that obtained by Ottaway and Simkiss (1979) (2.6 cm, $P < 0.001$).

Varations in growth rate of bass between different regions are obvious. In the Mediterranean, bass growth is much faster (Barnabé, 1980), while in U.K. (Kelly, 1988) bass grows more slowly than in the Biscay coast of France (Boulineau-Coatanea, 1969 ; Lam Hoai Thong, 1970) and much slower than on the Mediterreanean coast of France (Barnabé, 1973). These variations are mainly attributed to sea temperature (Alliot *et al.*, 1983) and food availability.

Many authors have reported that female bass are generally longerlived, faster growing, heavier and possibly more hardy than males of the corresponding length. The present work has confirmed these sex variations except those for growth rate that likely to be small. The reason for that, may refer to the fewer number of large specimens (> 43 cm) particularly males. Perhaps because large male bass tend to remain off shore (Kelley, 1988) away form the reach of local fishing gear. The same author assumed behavioural differences between sexes.

A great similarity between back-calculated lengths and weigths, as well as length/ weight equations, as established by Rafail (1971) and the present work's is remarkable. Therefore, bass growth rate in local waters has not been changed appreciably after daming the Nile in 1964. Generally, adult bass are more subjected to seasonal variation in their condition

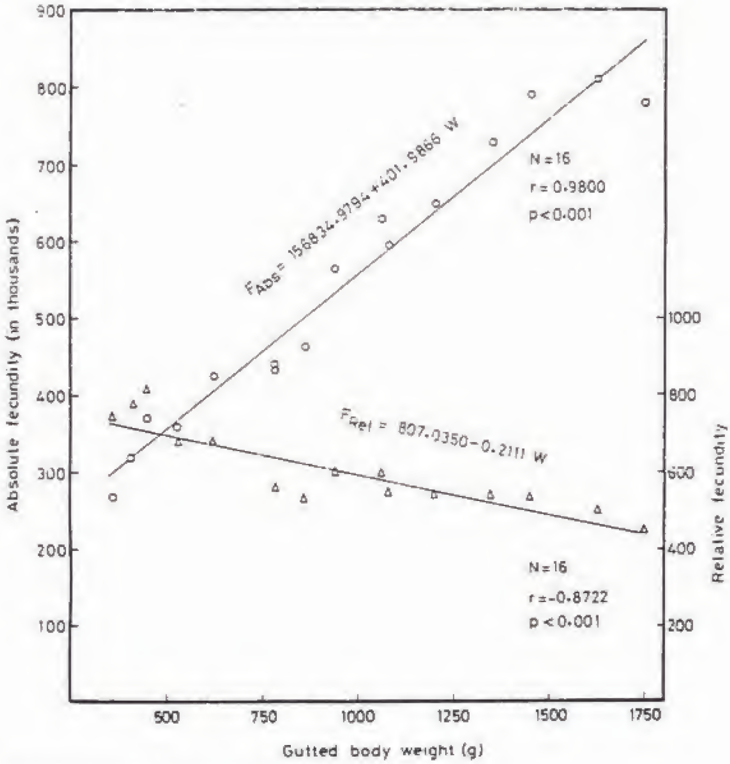

Fig. 11 : Fecundity/weight relationship for bass *D. labrax*.

Table VI : Percentage frequency distribution of immature and mature fish per length group for both sexes of bass *D. labrax*.

Males						Females					
Length group (cm)	Total No.	Immature		Mature		Length group (cm)	Total No.	Immature		Mature	
		No	%	No	%			No	%	No	%
16	--	--	--	--	--	25	5	5	100.0	--	--
17	7	6	85.7	1	14.3	26	6	5	83.3	1	16.7
18	10	7	70.0	3	30.0	27	11	8	72.7	3	27.3
19	12	7	58.3	5	41.7	28	9	6	66.7	3	33,3
20	11	5	45.5	6	54.5	29	10	5	50.0	5	50.0
21	10	3	30.0	7	70.0	30	7	3	42.9	4	57.1
22	6	1	16.7	5	83.3	31	5	1	20.0	4	80.0
23	2	--	---	2	100.0	31	9	1	11.1	8	88.9
24	9	--	--	9	100.0	33	4	--	--	4	100.0

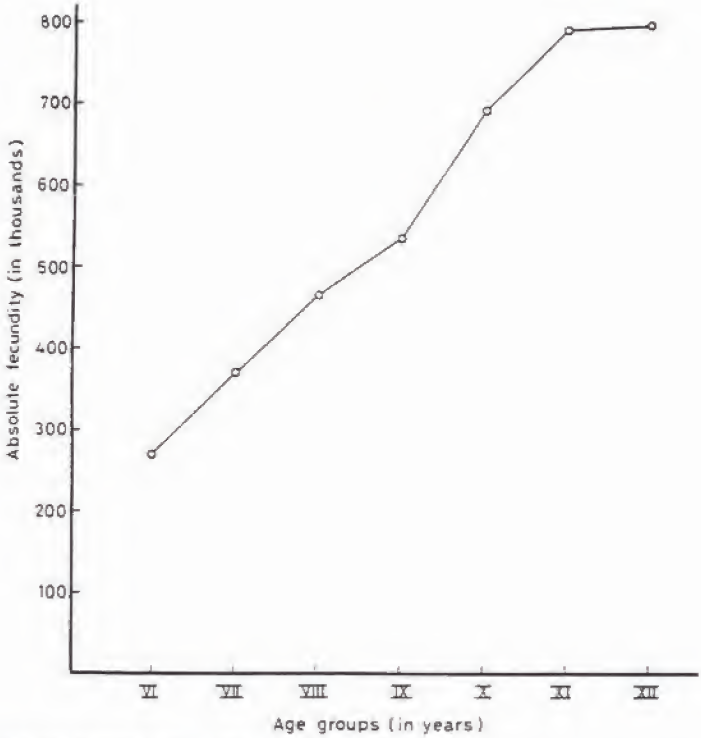

Fig. 12 : Correlation between fecundity and age for bass *D. labrax*.

than juveniles. Females have usually slightly higher condition values than males (Fig. 6). The three peaks of conditon may be reflection of feeding activites during the same month or a month later (Wassef *et al.*, 1985a). Whereas, the drop identified for female's curve may be related to first maturity.

Parameters of Bertalanffy's growth equation, as obtained from the present work, are not comparable with those previously computed for other regions. Since these values are not constant but vary according to fish age considered in calculating theses parameters.

Time of bass breeding differs from one location to another. Very broadly, more or less the same period in the Mediterranean : December to March in Tunisian waters (Bou Ain, 1977) ; January to March in Sète, France (Barnabé, 1973) ; December to March or April in Egypt (Rafail, 1971 ; present work). Whereas, it is later, March/April, for the Atlantic coast of France (Stequert, 1972) and April to mid June or early July in Irish waters (Kennedy and Fitzmaurice, 1972).

Age at first maturity, as given in the present work, accords closely with that reported for the Mediterranean bass in Tunisian waters (Bou Ain, 1977) and Sète, France (Barnabé, 1973). While it is earlier than that for the european bass off Ireland and western U.K. waters, 4-7 for males and 5-8 for females (1988).

Barnabé, 1980 noticed that bass pelagic eggs that obtained from the Mediterranean are smaller than those from the Atlantic. He attributed that to salinity and temperature variations. Consistant observations on many other species proved that eggs tend to be larger in waters of lower salinity and lower temperature (Kennedy and Fitzmaurice, 1968). The same authors gave the same trend of variation for both absolute and relative fecundities of bass with fish length as in the present work.

Acknowledgements : The authors would like to thank Prof. Dr. N. Dowidar and Prof. Dr. A. Ezzat, Faculty of Sciences, Alexandria University, for their help and assistance during this work.

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Reçu le 24.07.1987.
Accepté pour publication le 05.01.1989.